The Northwest Technology Transfer Center
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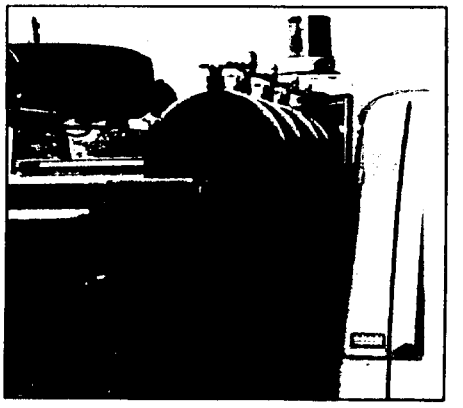
A newsletter of the Rural Technical Assistance Program (RTAP)

INSIDE

Please check mailing on back. If incorrect, please contact Donna Stallings at the Center.

Driving Into the Future With Natural Gas

by Peter Ing (R&F) and Laurence Hung (ESSB)



Have you ever wondered what the vehicle in front of you is trying to advertise with the letter "NGV" stuck on its side? No, the driver is not trying to tell you he just came back from a "No Good Vacation," instead he is advertising an alternative fuel technology, "Natural Gas for Vehicles." Actually, there are already over 700,000 natural gas vehicles in operation in over 35 countries in the world, with the top three leaders being Italy, the former Soviet Union, and New Zealand. Canada and the United States also have significant NGV populations. Alberta Transportation and Utilities (AT and U) is currently conducting an alternative fuel demonstration program involving 1991 light duty trucks. In a joint research project, the Equipment, Supply and Services Branch and Research and Development Branch will be converting 10 trucks to operate on a dual fuel (natural gas and gasoline) system. This demonstration program will quantify the environmental benefits of natural gas, compare the operating costs of NGVs to gasoline vehicles and evaluate customer acceptance of NGVs when used in actual field operation.

What is NGV?

Natural gas used for vehicles is the same gas supplied by your utility company to fuel your furnace for heating your home, except the gas is compressed to 3,000 psi for easy storage on board a vehicle. Compressed natural gas (CNG) consists of mostly methane and has an octane rating of 120 which is the highest of all the hydrocarbon fuels. Natural gas is one of Canada's most abundant natural resources; therefore, it has the best potential to be the choice for an alternative vehicle fuel.

Keeping the Air Clean

As a fuel for vehicles, CNG has many advantages. It has the potential of being the cleanest of all conventional and alternative vehicle fuels when considering all exhaust emissions. Natural gas contains no lead, produces no particulate matter, emits significantly less carbon monoxide than gasoline and generates only very little amounts of reactive hydrocarbons which can contribute to smog.

Safer Than Gasoline

CNG is also very safe. It's lighter than air and dissipates quickly when accidently released into the air; therefore NGVs are permitted to be parked in an enclosed area such as underground parking lots. Natural gas is neither corrosive nor toxic and the storage cylinders on the vehicle are very damage resistant and much stronger than gasoline tanks.

Low Operating and Maintenance Costs

Operating costs are lower for NGVs. The current price of natural gas is 32¢/kg (approximately 22¢/litre on an energy equivalence to gasoline). This price is more stable because unlike gasoline, it is not affected by the fluctuations of prices created by the world petroleum producing countries.

Maintenance and repair costs will also be lower with vehicles operating on natural gas because of the clean burning properties of the fuel. There are virtually no deposits on the cylinder walls and valves; therefore, spark plug life and oil change intervals may be extended in NGVs.

Ease of Fueling

Fueling the vehicle with natural gas is no different from gasoline. Fast-fill stations can refuel a vehicle within 3 to 5 minutes. There are also small outdoor compressors available on a rental basis that could be hooked up to your existing utility gas lines to deliver fuel to the cylinders of the vehicle on a slow-fill basis.

Trade-offs

Natural gas has a few disadvantages for vehicle use. The major one is the limited range that is available per fuelling due to the relatively low energy density per unit volume of the compressed gas in the storage cylinders. But since our NGVs operate on a dual fuel system, the total range of the vehicle is actually increased due to the added range achieved with natural gas. Other drawbacks are a decrease in payload due to the added weight and size of the fuel cylinders and a decrease in engine performance. Currently there are electronic spark advance devices to help offset decreased engine performance. The shortage of fuelling stations in Alberta poses another problem for NGVs. There are presently two public fast-fill fuel line stations in Edmonton and one in Calgary with additional stations scheduled to operate in Alberta by 1992. Other private fast fill stations are currently available but permission to use these stations must be granted by the station owners.

Future Outlook

The result of this demonstration program will help AT and U determine whether dedicated NGVs from the major automotive manufacturers might be purchased in the near future. GM should have trucks operating on CNG for consumers by 1994. Chrysler may have them by 1993. With the limited world supply of petroleum fuel and an increased awareness of environmental issues such as global warming, natural gas for vehicles has a strong potential to be the best alternative vehicle fuel for the future. The Equipment, Supply, and Services Branch will be assigning the converted vehicles to districts interested in participating in this demonstration program. The shops participating currently are Edmonton, Sherwood Park, Athabasca, Vegreville, and Leduc. For more information or the progress of this program, please contact Laurence Hung (ESSB) at 427-8310 or Peter Ing (R&D) at 422-2750.

(Source: "Transearch," Alberta Transportation and Utilities, December 1991.)

[Editor's Note: A recent article in WSDOT's employee newsletter of March/April noted that WSDOT, King County, Kirkland, and Enumclaw have equipped some vehicles to use compressed natural gas (CNG).]

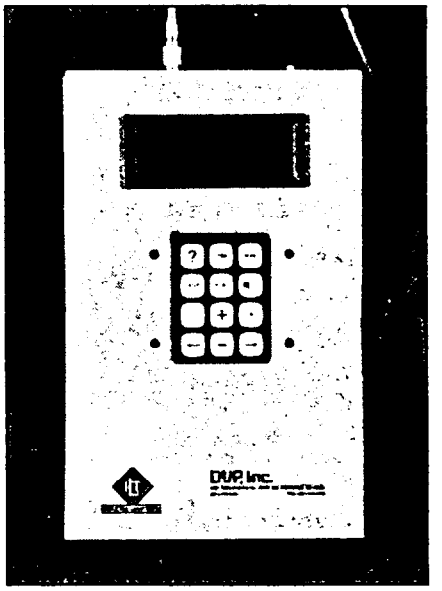
In the News

Accurate Handheld Loop Detector Testing Device Developed

The most commonly used form of vehicle detector for traffic control systems is the loop detector, so called because it consists of a loop of current-carrying wire buried in the pavement. A large mass of metal, such as an automobile, passing over the loop reacts with its electromagnetic field to induce voltage changes in the loop circuit. This change in "inductance" is measured and interpreted as a vehicle passage. Unfortunately, loop detectors are subject to frequent malfunctions that render them inaccurate or nonoperational; moreover, they are difficult to analyze under operating conditions.

However, a convenient method for testing loop detectors in place has been developed under the sponsorship of FHWA through the Small Business Innovation Research Program. The digital loop test instrument developed cannot only quickly diagnose faulty inductive loop detector (ILD) systems, but it can also be used in acceptance testing of new ILD systems and help with preventive maintenance.

This portable, handheld instrument has a measurement accuracy of 0.02 percent because of a unique digital signal processing technique for making measurements and displaying and interpreting the results. The instrument can measure loop inductance, quality factor (a measure of efficiency), and resistance, and do so at frequencies from 10 to 100 KHz, thereby covering the operating frequency range of all commercial loop detector electronics. The instrument can also measure the operating frequency of the loop and its detector electronics after they have been connected together — something that has not been possible before. The capability to measure the inductance change caused by a variety of vehicles (such as bicycles or highbed trucks) as they cross the loop allows the required sensitivity of the detector to be accurately adjusted.



The manufacturer of the device has completed prototype development, and the instrument is now in production. FHWA will arrange for the loop test instrument to be field tested in several locations under actual operating conditions. If the field tests are successful, information on the test instrument will be disseminated through FHWA's technology transfer program.

(Source: FHWA's "Research & Technology Transporter" December 1991.)

Senate Passes Energy Bill

The Senate in February by a vote of 94-4 passed a comprehensive energy bill that will require automotive fleets operated by federal, state, and local governments, schools and private businesses to switch to alternative fuels beginning in 1995.

Title IV of the National Energy Security Act of 1992 (S. 2166) would require that by the year 2000, 90 percent of the vehicles leased, purchased, or acquired by federal agencies for their fleets must be operated by alternative fuels. In addition, the federal government would be required to purchase or lease 5,000 alternative fueled vehicles by 1993, 7,500 by 1994, and 10,000 by 1995.

Alternative fuels defined under the bill would include ethanol, methanol, compressed natural gas, electricity, and fuels derived from vegetable oils or other biomass sources.

The bill also contains provisions to encourage research on the production of electric vehicles, including research on electric-hybrid vehicles, solar-assisted vehicles and recyclable batteries.

(Source: The AASHTO Journal, Volume 93. No. 8, Feb. 21, 1992.)

Are You at Risk for CTS?

You extend your hand to greet your new supervisor; but when he shakes it, you feel a sharp, burning pain. All the next day your hand and wrist feel numb.

The diagnosis is a shock. You have carpal tunnel syndrome — CTS for short. CTS is caused by making the same motion over and over in a job. Packers, painters, assembly line workers, cashiers, and people who work at computer keyboards all day are prone to this disease. CTS is one of the leading claims for workers' compensation.

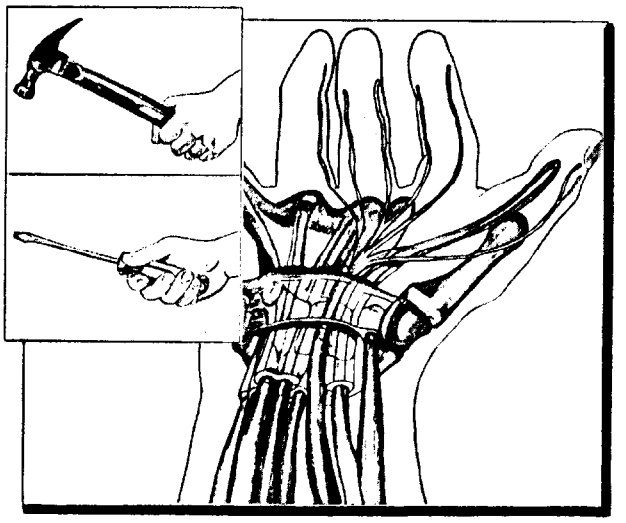
Why Your Hand Hurts

The carpal tunnel is the bony cavity in your wrist through which nerves and tendons extend to the hand. When you repeat the same hand and wrist movements day in and day out, the strain causes tendons to swell and press on the main nerve of the hand. This persistent nerve irritation can result in pain, numbness, and dysfunction, not only in the hand and wrist, but sometimes extending up to the forearm and elbow.

What You Can Do About It

By learning how to modify the way you use your hands, you can minimize the risk of CTS. Here are some ways to prevent the condition:

- ❑ Try to keep your wrist straight. Avoid using your wrist in a twisted position for long periods of time.
- ❑ Reduce repetition. Even simple tasks can eventually cause injury when repeated over and over. Avoid movements that require holding an object the same way for long periods of time.
- ❑ Slow down and use only enough force to control hand tools. When you slow down, your hand has time to recover from each effort.
- ❑ Watch your grip. Using just the thumb and index finger can put pressure on your wrist. When practical, use your whole hand to grasp an object.
- ❑ Give your hands a break from time to time. Alternate the easy and hard jobs or switch hands.
- ❑ Take action early if you notice symptoms; don't wait for them to become unbearable. The earlier you have a professional diagnosis, the more successful the treatment.



Using just the thumb and index figure to grasp an object can put pressure on your wrist. When practical, use the whole hand.

New Surgical Technique Speeds CTS Recovery

When diagnosed early, CTS can be treated by stopping the repetitive motion and splinting the wrist. However, more severe cases require surgery to relieve pressure on the nerve.

A new surgical technique allows those with CTS to return to work in about half the time required by conventional surgery. The new procedure uses an endoscopic instrument similar to that used for knee surgery to make a small incision in the patient's wrist instead of in the patient's hand. Patients who have the endoscopic procedure are able to return to work in about 25 days, whereas those who have the conventional open-carpal-tunnel surgery usually require 46 days to recover.

WHERE TODAY
MEETS TOMORROW

A Northwest Event!
September 15-17
Clark County Fairgrounds
Vancouver, Washington

- ❑ 163 acres of exhibits and demonstrative equipment use
- ❑ Indoor displays of equipment, products, and services
- ❑ Free seminars
- ❑ Free registration if pre-registered

PIE is a trade exposition with exhibits of equipment, materials, tools, and services available to utilities, governmental agencies, and contractors. In addition workshop presentations provide fresh insights into the latest technology and ways of doing things in public works construction.

Planned exhibits include: heavy construction equipment, various truck bodies, truck mounted equipment like digger derricks, cranes, and generators; trenchers, backhoes; hydraulic equipment; safety equipment; conduits; communication products like fiber optics; test equipment; automated controls; and many others.

Seminars also will be given on techniques for training equipment operators, safety standards including OSHA, and environmental issues, regulations, and procedures.

What Others Say:

Mr. Robert R. Axelson, WSDOT Equipment Manager, notes "This show gives all operators and equipment people a place where they can go to view and compare equipment and accessories in *one location* that would otherwise be unavailable to the majority of these people. Visiting the PIE show will be cost effective and informative when looking for new or innovative equipment."

Neil Gaiser, Equipment Manager for Pierce County Public Workers says, "Over the past four years we have been sending employees of Pierce County Public Works to the Equipment Exposition. This once a year Expo affords our employees a chance to see what is new in the equipment line as well as gathering new information on "Hot Topics" in the seminars offered. We have been able to put to use some of the new ideas that have been brought back from the Expo."

For more information contact

Pacific International Exposition • 523 NE Columbia Boulevard • Portland, OR 97211

800-624-2569 • (503) 285-3069 • FAX 503-285-3269

Employee Development

Educational Opportunities

The purpose of this column is to inform you of the numerous educational opportunities that exist for our Washington State and adjacent states' transportation people. We also place this information on our electronic bulletin board.

Northwest Technology Transfer Center (206) 753-1028

The T^2 center offers or supports numerous workshops of interest to public works agencies in Washington. Announcements are advertised in the newsletter, the Bulletin, and flyers are sent out to public works agencies requesting their interest prior to the workshops.

- ❑ EEO, OJT, and DBE Workshop May 5 at Yakima Red Lion; May 13 at Renton Holiday Inn.
- ❑ APWA's Workshop, Effective Management in Workplace 2000. April 30-May 1, SeaTac area.

County Road Administration Board (CRAB). If there is a special class you would like to see developed for counties, contact CRAB at (206) 753-5989.

Battelle (206) 527-0524

Registrations for workshops are taken on first come, first serve basis. Call Battelle for additional information.

- ❑ The Manager as a Leader. June 1-2 and December 7-9, Seattle. Cost $1,145.
- ❑ The Effective Manager. October 13-15, Seattle. Cost $895.
- ❑ The Engineer as a Manager. June 1-2 and December 3-4, Seattle. Cost $975.
- ❑ Effective Project Management. October 5-6, Seattle. Cost $975.
- ❑ Managing Computer Projects. May 11-12, July 27-28, and November 16-17, Seattle. Cost $975.

Asphalt Institute (206) 786-5119

- ❑ Asphalt Conference. October 22, Moscow, Idaho. Contact Ed Schlect.

American Society of Civil Engineers 1-800-548-2723

- ❑ Advances in High Performance Cements and Concretes. April 27-29, Seattle. Members $745, nonmembers $855.

Wright State University (513) 224-8511

- ❑ How to Plan, Estimate, and Schedule Maintenance. May 7-8, Seattle. Contact Heather Copas (513) 224-8511. Cost $645.
- ❑ How to Organize and Manage a Preventive Maintenance Program. June 4-5, Seattle. Contact Heather Copas (513) 224-8511. Cost $645.

Washington State University (206) 840-4575

- ❑ Innovative Compensation and Reward Programs for Team Based Performance. June 18-19, Red Lion Sea-Tac. Cost $795

CLE International (206) 621-1938

- ❑ Wetlands Update, May 14-15, Stouffer Madison Hotel, Seattle, Washington. Cost $395

National Seminars Group 1-800-258-7246

- ❑ Building Your People Skills. May 19, Olympia; May 20, Pasco; May 21, Spokane. Cost $75.

Fred Pryor Seminars 1-800-255-6139

- ❑ How to Make Presentations with Confidence and Power. June 1, Spokane; June 10, Seattle; June 11, Olympia; June 12, Tacoma. Cost $195.

National Business Woman's Leadership Association 1-800-258-7246

- ❑ Leadership and Supervisory Skills for Women. June 1, Spokane; June 2, Pasco; June 3, Yakima; June 4, Bellevue; June 5, Everett; June 10, Olympia; June 11, Tacoma; June 12, Seattle; June 9 and 19, Portland.

Padgett-Thompson 1-800-255-4141

- ❑ The Basics of Hazardous Materials Management, June 17, Portland; June 18, Seattle. Cost $125.

Conferences and Meetings

- ❑ Washington State Recycling Association's 12th Annual Conference Trade Show, May 31-June 2, Tacoma, Washington.
- ❑ 8th Annual WSDOT/RTPO Intermodal Planning Conference, June 2-4, Tumwater, Washington.
- ❑ National Public Works Week, May 17-23.
- ❑ AASHTO Task Force on Geometric Design, July 19-24, Newport, Oregon.
- ❑ AASHTO Joint Development Task Force Meeting, July 26-27, Seattle, Washington.
- ❑ National T² Conference, August 2-5, 1992, Lexington, Kentucky.
- ❑ Pacific Rim Transtech Conference, August 12-19, 1993, Seattle, Washington. For more information, contact James R. Buss, WSDOT, (206) 753-6014.
- ❑ Pacific International Exposition (PIE), September 15-17, 1992, Clark County Fairgrounds, Vancouver, Washington. Contact Jeannie Perrin, 1-800-624-2569.
- ❑ Road and Street Maintenance Supervisors School, October 6-8, Spokane Red Lion; November 4-6, Everett Pacific.
- ❑ Northwest Concrete Pavement Short Courses and Seminar, October 13-16, 1992, Red Lion Columbia River Hotel, Portland, Oregon. Contact Jean Canfield, (206) 943-7732.
- ❑ Asphalt Conference, October 22, Moscow, Idaho. Contact Ed Schlect, (206) 786-5119.
- ❑ 62nd Annual Meeting. ITE, August 9-12, Washington, DC.

28 Secrets to Happiness

- ✻ Live beneath your means and within your seams.
- ✻ Return everything you borrow.
- ✻ Donate blood.
- ✻ Stop blaming other people.
- ✻ Admit it when you make a mistake.
- ✻ Give all the clothes you haven't worn in the last three years to charity.
- ✻ Every day do something nice and try not to get caught.
- ✻ Listen more; talk less.
- ✻ Every day take a 30-minute walk in your neighborhood.
- ✻ Skip two meals a week and give the money to the homeless.
- ✻ Strive for excellence, not perfection.
- ✻ Be on time.
- ✻ Don't make excuses.
- ✻ Don't argue.
- ✻ Get organized.
- ✻ Be kind to kind people.
- ✻ Be even kinder to unkind people.
- ✻ Let someone cut ahead of you in line.
- ✻ Take time to be alone.
- ✻ Reread a favorite book.
- ✻ Cultivate good manners.
- ✻ Be humble.
- ✻ Understand and accept that life isn't always fair.
- ✻ Know when to say something.
- ✻ Know when to keep your mouth shut.
- ✻ Don't criticize anyone for 24 hours.
- ✻ Learn from the past, plan for the future, and live in the present.
- ✻ Don't sweat the small stuff.

(Source: "Washington Wellness" Volume V, No. 1, Winter 1992.)

Selected References

The following can be obtained directly from the sources listed.

Hot Mix Asphalt Materials, Mixture Designs, and Construction. This new book by the National Asphalt Pavement Association (NAPA) with over 500 pages covers asphalt refining, uses, and properties; aggregates; HMA mixture design; asphalt mixture properties; equipment and construction; special mixtures, recycling, and additives; performance/distress of HMA. Available for $45 from NAPA Education Foundation, NAPA Building, 5100 Forbes Boulevard, Lanham, MD 20706-4413 or telephone (301) 731-4748.

12 Tools for Improving Mobility and Managing Congestion. The Urban Land Institute created this booklet to build upon previous publications by identifying successful tools that are being used by many communities to reduce traffic congestion. A wide array of approaches and ideas are noted. Contact Urban Land Institute, 625 Indiana Avenue NW, Washington, DC 20004 or telephone 1-800-321-5011.

Hot Mix Asphalt Paving Handbook. Covers the state of the art of asphalt paving operations including plant operations, transportation of materials, surface preparation, laydown, and compaction. It is aimed at field personnel who do the work and agency personnel who oversee and inspect the work. Available from APWA, PO Box 94310, Chicago, IL 60678-4310. Members $25, nonmembers $30.

Tackling Gridlock. Shows how to improve traffic flow, increase traffic capacity, encourage mode shifts, and manage the traffic system. It makes the congestion problem less perplexing and provides public works administrators, decision makers, and other municipal officers with solutions. APWA. Members $20, nonmembers $30.

Selection and Use of Engineering and Architectural Consultants: Guidelines for Public Agencies. APWA's Institute for Municipal Engineering's latest publication on how to work successfully with engineering and architectural consultants. $5.

Committing to the Cost of Ownership: Maintenance and Repair of Public Buildings. A comprehensive report from the Building Research Board that demonstrates you should be budgeting 2 to 4 percent of the aggregate current replacement value of buildings for routine maintenance and repair. APWA. Members $20, nonmembers $25.

Public/Private Partnership in Transportation. This special 100-page, fully-illustrated manual has been prepared by the American Road & Transportation Builders Association, the nationally-recognized educational leader in the public/private partnership field. It is written by internationally respected

consultants from firms like Arthur D. Little, Price Waterhouse, Public Financial Management, Morgan Stanley & Company, and Parsons Brinckerhoff Quade & Douglas. And its unique binder format means you'll be able to update your manual as ARTBA-produced revisions are made available. $100. Contact ARTBA, 501 School Street SW, Washington, DC 20024.

Complete Manual of Land Planning and Development. William E. Brewer and Charles P. Alter. This guide gives you in-depth coverage of planning and developing sites. Included are design stormwater drainage structures ... construct sanitary sewage systems ... plan pavement projects ... interpret soil test data ... work more effectively with building and zoning regulations ... and more. The tips and techniques are fully illustrated to ease you through every procedure. Computer applications and methods for determining feasible cost calculations on every project are also included. Pub. 1988, 256 pp., 115 illus, 7 x 9 ¼". Available through Prentice Hall, Book Distribution Center, 110 Brookhill Drive West, Nyack, NY 10995-9920.

AASHTO's Guide for the Development of Bicycle Facilities. This guide, which supersedes the 1981 *Guide for Development of New Bicycle Facilities*, provides information on the development of new facilities to enhance and encourage safe bicycle travel. Planning considerations, design and construction guidelines, and operation and maintenance recommendations are included. Price per copy: $8 plus postage. Available through AASHTO, 444 North Capitol Street NW, Suite 225, Washington, DC 20001/ USA.

European Asphalt Study Tour. This report presents the findings of a 14-day study tour examining innovative asphalt paving techniques in Denmark, France, Germany, Italy, Sweden, and the United Kingdom. This project was a joint effort of AASHTO, the Federal Highway Administration, the National Asphalt Pavement Association, the Strategic Highway Research Program, the Asphalt Institute, and the Transportation Research Board. Price per copy: $3.50 plus postage. Available through AASHTO, 444 North Capitol Street NW, Suite 225, Washington, DC 20001/USA.

Hazard Communications Standard: A Guide for the Construction Industry. This OSHA-approved manual details all the requirements for compliance with OSHA's Hazard Communications Standard. Includes sample programs and copies of necessary documents. ARTBA members $17, nonmembers $22. Contact ARTBA, 501 School Street SW, Washington, DC 20024.

Fighting Substance Abuse in the Workplace: What Every Employer Needs to Know. Develop and implement a drug-free workplace program. Includes sample company policies, listings of state agencies, and federal workplace drug law. ARTBA members $20, nonmembers $30.

Free Publications

For Washington recipients only: Contact Donna Stallings at (206) 753-6119 or SCAN 234-6119 if you want publications.

A Guide for Erecting Mailboxes on Highways, AASHTO. This recent guide by AASHTO provides recommended practice for their location, design, and regulation. Designs which are hazardous to the motoring public can be replaced with simple and inexpensive designs. A model regulation is provided for accommodating mailboxes and newspaper delivery boxes on public highway rights of way (10 copies available).

FHWA-FL-90-006, Fish Passage Through Culverts. This booklet provides a set of broad guidelines for the engineers and the biologists to design, construct, or maintain an acceptable structure with fish passage capabilities (15 copies available).

FHWA-RT-88-039, Improving Operational Safety on Local Roads and Streets. U.S. Department of Transportation. This pamphlet is intended as a general guide to effective, low-cost methods of improving and enhancing operational highway safety. The guidelines and examples included are based on actual situations and observations made in a series of nationwide reviews (25 copies available).

Improving Guardrail Installations on Local Roads and Streets. U.S. Department of Transportation. This pamphlet is intended as a general guide to effective, low-cost methods of enhancing highway safety with guardrails (15 copies available).

Maintenance of Small Traffic Signs. U.S. Department of Transportation. This handbook is intended to help maintenance workers to understand the importance and the priority of maintaining small traffic signs (20 copies available).

Traffic Notes

Signing for Impaired Vertical Clearance

by Ed Lagergren

RCW 46.44.020 establishes the maximum legal vehicle height in the state of Washington at 14 feet 0 inches. The RCW states that no liability may attach to the agency for vertical clearances greater than 14 feet or for vertical clearances less than 14 feet when properly signed in accordance with the MUTCD. It is the intent of this article to give you information on the correct signing for impaired vertical clearance and provide guidance for taking field measurements.

The MUTCD Section 2C-34 Low Clearance Signs (W12-2) sets forth the criteria for signing impaired vertical clearance. Clearances less than the maximum vehicle height permitted (14 feet 0 inches) plus 12 inches (15 feet 0 inches) should be signed. In addition where the clearance is less than the legal limit (14 feet 0 inches) signing to that effect should be placed at the nearest intersecting road or wide point in the road at which a vehicle can detour or turn around.

Because of many variables affecting the effective height of a moving vehicle, it has been determined signing shall designate the usable clearance which is normally determined by actual field measurement less three inches. When a roadway sag vertical curve is located below a structure, it may be necessary to apply the additional clearance allowance required by a 50 foot subtending chord to determine the usable clearance.

The RCW also makes it the duty of a nonpolitical subdivision owner (most commonly a railroad) of a low structure to reimburse the political subdivision having jurisdiction over the highway for the actual cost of erecting and maintaining the impaired clearance signs.

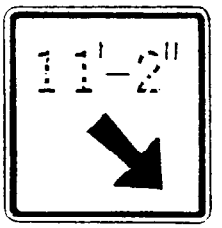
Guidelines for Signing Bridge Vertical Clearances

Uniform signing of the structure usable clearances should be established by the following procedures:

Low Clearance Signs (W 12-2, W 12-301, W12-302)

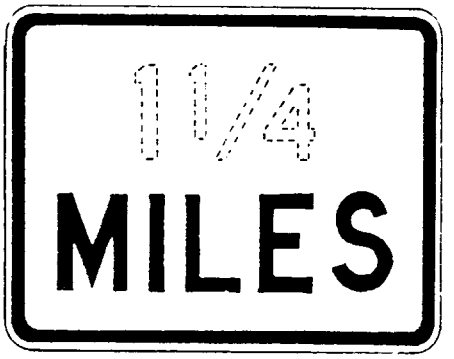
The Low Clearance sign is intended to warn motorists of usable vertical clearances at low bridges, undercrossings, and other overhead structures where the usable clearance is less than 15 feet 0 inches. The sign W 12-2 should be erected on the shoulder. Use Table II-1 Condition B to determine the sign placement distance from the restricted clearance. In the case of an arch or other structure under which the clearance varies greatly, two or more W 12-301 signs (Figure 1) should be used as necessary on the structure to give accurate usable clearance information over the entire roadway.

The sign W 12-302 may be used to designate prominent clearance restrictions and limits of usable clearance less than 14 feet 0 inches.

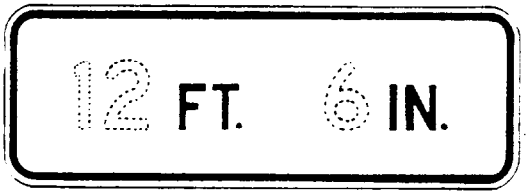


W 12-302

W 12-2



W 13-501



W 12-301

Advance Low Clearance (W 12-2, W 13-501)

Advance Low Clearance signing is intended for use in advance of a structure having usable vertical clearance less than the legal clearance of 14 feet 0 inches. Sign W 12-2 showing the usable clearance in feet and inches (same as that shown on the Low Clearance Sign installed near the structure) shall be erected at the nearest intersection where vehicles may select a detour, or at a point where the roadway is sufficiently wide for vehicles to turn around. Advance Distance Sign W 13-501, when appropriate should be used as part of the Advance Low Clearance Assembly.

Clearances shall be checked at all structures located in areas where resurfacing operations, grade revisions, or structure modifications have taken place.

Guidelines for Measuring Bridge Vertical Clearances

Vertical clearance information is utilized to determine the possibility of permitting movement of various shape vehicular loads. Geometrics associated with roadway and bridge profile grades, superelevation, and crown are often subtle factors affecting the usable clearances. These factors add to the difficulty in locating the critical points to measure.

The following guidelines are for use in taking and recording measurements from which usable vertical clearance information is determined. Figure 2 shows the desired form for vertical clearance information.

Undercrossing Structures

Measurements should be taken at each lane stripe and at the edge of shoulder along both sides of the bridge. (See Figure 2) Geometrics which require additional measurements are:

A. **Parabolic or haunched shape openings.** When the clearance limiting member is parabolic shaped, additional clearance measurements need to be taken for two lane wide openings. These measurements should be taken at 5 feet and 10 feet each side of the parabola apex. The apex is normally located at the roadway centerline. If the overhead member is haunched, clearance measurements should be taken at the end of the haunches.

B. **Superelevation.** The effects of superelevation are very subtle and normally reduce the vertical clearance only at points where the perpendicular from the roadway slope intersects a structure member which is at a lower elevation than vertically above the point where the measurement is being taken.

C. **Sag Vertical Curves.** Sag vertical curves created an addition problem by raising the body of a long truck further above the roadway midway between the axles than it is at the axles. Take this into consideration by profiling the roadway 50 feet each side of the structure and the vertical clearance recorded should be that taken from the 50-foot subtended chord which has the highest elevation at the structure.

Thru Structures (Truss Type Bridges)

Vertical clearance measurements are required at intermediate lane stripes and at the curb. Measurements must be taken at each portal and sway frame to determine the controlling member. This member should be identified on the diagram. If the member is parabolic or haunched, take measurements as indicated in Undercrossing Structures, paragraph A.

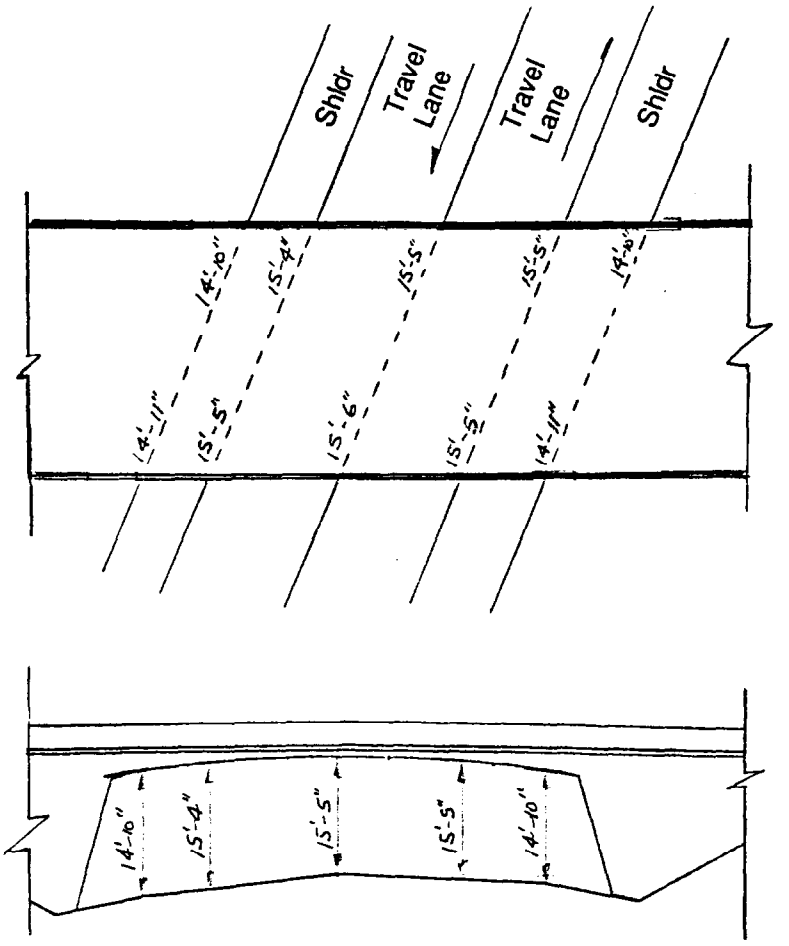


Figure 2

Vertical Clearance
Road A at Avenue B
By: ABC Date: 4/20/92

The Technology Transfer (T²) Program is a nationwide effort financed jointly by the Federal Highway Administration (FHWA) and individual state departments of transportation. Its purpose is to translate into understandable terms the latest state-of-the-art technologies in the areas of roads, bridges, and public transportation to local highway and transportation personnel.

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